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Agricultural Memorandum No 1096

Assessment of experimental forecasts of Smith Periods during the Potato Blight weather trial service in 1987.

Abstract

Experimental 5-day forecasts of Potato Blight Weather, issued as

(i) Smith Periods, calculated automatically for 40 x 40 km gridsquares, issued daily on FARMLINK, and

(ii) a Blight weather message, designed to be recorded on answerphone

were provided to ICI in a trial service available to a limited number of growers and merchants in South West England.

Analysis showed that

(1) the first onset of Blight weather was predicted quite successfully by the forecasts

(2) forecasts of Smith Periods are significantly overestimated compared with those calculated to have occurred from meteorological observations in the grid squares

(3) automated forecasts up to 2 days ahead performed better than chance, both for negative and positive predictions of Smith Periods, but they showed little skill by forecast day 5

(4) the text forecast message was useful to ICI in borderline cases and to clarify the automated forecasts but the answerphone service was under used.

Keywords: Potato blight forecasts, Smith periods

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1. Introduction

South West England is a major potato growing region (for both Earlies and Main Crop varieties) and is particularly susceptible to outbreaks of the fungal infection Potato Blight (Phytophthora Infestans), which thrives only in mild, humid conditions.

Much work has been done to identify the weather characteristics which determine the spread and development of Potato Blight. The Smith Period, although not a particularly sophisticated parameter, has the advantages of widespread usage in the UK and of being easily understood by growers and other users.

A Smith Period is defined as having occurred when for each of two consecutive 24 hour periods the minimum temperature is at least 10°C and the relative humidity is 90% or above for at least 11 hours. Relative humidities of 90% or more for 10 hours in each 24 hour period are considered to be a near miss, provided the temperature criterion is satisfied. The 24 hour period was traditionally from mid-day GMT but work has shown that a switch to a 24 hour period beginning at 0900 GMT has little effect (M Lee - private communication). This period is adopted for forecasts of Smith Periods.

An experimental service was set up in conjunction with ICI, who manufacture fungicide sprays for the control of Potato Blight, whereby ICI Plant Protection Division (south west region) personnel and a selection of other interested users in the South West contacted by ICI - potato growers, spray merchants and consultant agronomists - had access to daily forecast information on Potato Blight weather to 6 days ahead in the form of Smith Periods for 40 x 40 km grid squares. The grid is the same as that used by the MORECS (Met Office Rainfall and Evaporation Calculation System) service. The region covered is shown in Figure 1.

Smith Periods forecasts were provided to users by the Met Office for the period 21 April-31 August 1987. Dissemination of information was in two forms:

i. Tabulated daily automated forecasts of Smith Periods/non-Smith Periods for each of the 6 forecast days (forecast day 0 being the day of issue of the midnight forecast) on AGVISER (videotext display), updated daily (see Figure 2).

ii. An answerphone message updated Monday to Friday (for example, see Figure 3). The message was prepared by Met O 3c each day after consultation with the Medium Range Forecaster at CFO, who received a copy of the automated forecast of Smith Periods and details of the two criteria used (see Figure 4). The message was DOCFAXed to ICI who recorded it for answerphone.

Model Output Statistics (MOS) were used to calculate minimum temperatures each day for up to 6 days ahead. The calculations were made for about 140 stations in Great Britain and the station values were interpolated onto the 40 x 40 km grid using a biquadratic surface fitting technique. 'Printfile' 1000 mb relative humidities were used to calculate the number of hours in a

0900 GMT day with relative humidities ≥ 90%. Fine mesh data were used for forecast day 0. Coarse mesh was used thereafter, with linear interpolation between 6 hourly or 12 hourly values (Lee, 1987).

2. Use of Smith Periods

Blight fungicides are only effective as protectants not as erradicants. They need, therefore, to be applied before the disease occurs. There are two types of fungicide, systemic and contact. Systemics are distributed through the plant by the plant's own vascular system, so new growth is protected; contacts remain where they are applied, so give short-lived protection when growth of vulnerable new leaf is rapid. Systemics are applied at typically 14 to 21 day intervals, starting as soon as a Smith Period has occurred. The number of systemic sprays is limited due to resistance build up. The interval for contacts is shorter - 7 to 14 days. A regular spray schedule is followed but there are additional constraints. To be effective a 24 hour dry period is required and applications will depend on the rate of new growth in the crop; this tends to be most rapid in Blight favouring conditions. Since even partial Blight infection often means the economic loss of the entire crop, growers operate on a 'better safe than sorry' principle and take action even if there is only a slight chance of Blight weather.

The primary use of Smith Periods is to identify the start of the Blight season. Their secondary use within the season is as a qualitative index of Blight 'pressure' to guide the lengthening or shortening, within the above limits, of the inter-spray period.

3. Analysis

The performance of the forecasts was measured by comparisons with

i. 'Actual' Smith Periods, calculated by interpolation of hourly synoptic measurements of the relative humidity and the minimum temperature onto the 40 km grid squares.

ii. Smith periods recorded at synoptic stations.

iii. User perceptions of potato Blight weather.

Because the forecasts were produced on the basis of mean values for 40 x 40 km squares it was appropriate that the verification data should be on the same basis, so a Smith Period was deemed to have occurred when the mean conditions within a square fulfilled the Smith criteria, and not necessarily when conditions at a single station within the square fulfilled the criteria. The background to this approach is that observing stations in the south-west tend to be near coasts, while the ground inland may rise to significant heights above sea-level. By interpolating and height-correcting station values to mean values for a square any bias towards coastal values was reduced. It is important to note this distinction because the picture of blight weather that emerged from station values on the one hand, and square values on the other, displayed significant differences.

Analysis of the forecasts compared with (ii), Smith Periods recorded at synoptic stations, has been carried out by Hume (1988, private communication) for the period 1 May to 29 September 1987. On average, the number of Smith Periods recorded was about double the number of 'actual' Smith Periods calculated for the 40 km squares.

User perceptions of Blight weather tended to be quite vague, as might be expected with no available in-field measurements of temperature and humidity.

The user attaches most importance to the forecasts of:

i. The onset of Blight weather and

ii. The reliability of the forecasts of NON-Smith Periods.

Predictions given by the automated forecasts of the first occurrence of Blight weather in each square are summarised in table 1. A few cases, where the Smith Period is predicted solely from forecast days 4 or 5, were omitted. In general, predictions were well timed with respect to user perceptions. In a third of the squares the first Smith Periods were forecast to within 2 days of the 'actual'. Smith Periods for the 40 km squares, and to within a week in 80% of squares. In 3 out of the 4 squares where the first occurrences of Smith Periods were missed, the 'actual' Smith Periods were not supported by any Smith Periods occurring at stations within these squares. There was also reasonable agreement between the predictions and Smith Periods recorded at synoptic stations (see table 1).

Automated forecast Smith Periods for each forecast day were compared with 'actual' Smith Periods for the period 27 April to 31 August 1987 (see Table 2). The results fall into 4 categories:

a. Forecast = YES (A Smith Period; Actual = YES (A Smith Period)

b. Forecast = NO; Actual = NO

c. Forecast = YES; Actual = NO

d. Forecast = NO; Actual = YES

As growers always err on the side of caution, of the failure categories: (c) a 'false alarm' is not considered so serious whereas category (d) is a bad forecast.

'Actual' Smith Periods occurred on only 1 in 10 days and of these Smith Periods 80% were correctly predicted on forecast day 1 and 60% were correctly protected on the final 3 forecast days (see Table 3).

The reliability of automated forecasts in predicting NON Smith Periods correctly is better than 96% for the first 3 forecast days and 94% for the last 3 forecast days. Conversely, between 13 and 20% of forecasts predicting a Smith Period are correct. The success rate is low because the forecasts tend to overestimate the occurrence of Smith Periods (34% of all Smith Periods predicted were not recorded as 'actuals' in the 40 x 40 km

squares). However CFO guidance also tended to predict Smith Periods when none occurred in the 40 x 40 km squares. The automated forecasts were supported by local user perceptions and by Smith Periods recorded at synoptic stations which were about twice the number calculated to have occurred in the 40 x 40 km grid squares. The discrepancies may be caused by local effects, such as a bias towards coastal conditions, and the density of stations.

Considering category (d), all the 'bad' forecasts, apart from one, were borderline cases. That is, minimum temperatures were fractionally too low or, occasionally, the periods of high relative humidities were slightly too short. This often seemed to apply to square 190, the tip of Cornwall. The occasion when category (d) forecasts were not borderline (19 and 20 June 1987) was ammended by CFO guidance which correctly deduced that model relative humidities were too low.

Considering the performance in individual squares, Figure 5 shows the percentage of Smith Periods correctly forecast, averaged over all the forecast days. (The forecasts showed skill if the success was higher than 50%). Performance was slightly better in the north and east, and this effect is clearly shown by the predictions for forecast day 1 (Figure 6).

Square 189 has the lowest success rate (44% of Smith Periods were missed by the forecasts) for forecast day 1, which may be due to the orographic effect of Dartmoor, whereas squares in Avon, Dorset and Wiltshire (see Figure 1) where the station density is greatest generally have a very high success rate for forecast day 1 (see Figure 6). Figure 7 shows the percentage of incorrect forecasts for the grid squares. Again, totally unskilled forecasts would give a figure of 50%, but now forecast skill is demonstrated by figures below 50%.

One user cited a case of Smith Periods occurring in early May when both automated forecasts and the answerphone message were of no use. The user felt that Smith Periods had occurred in squares 188 and 189 due to sea mist caused by prevailing easterly winds. However, data recorded at Plymouth and Exeter during this period did not satisfy the Smith criteria.

The service tended to be used mainly before the end of July, at approximately daily or 2 day intervals in April and May and less frequently thereafter. Perhaps surprisingly, ICI reported a poor response to the answerphone service.

Telephone interviews were carried out with a small sample of users. A summary of the main points to emerge from the discussions with users of the forecasts is given in Appendix A.

4. Summary and Conclusions

Both forms of the forecast performed quite well in predicting the first occurrence of Blight Weather to within a couple of days, but there was a tendency for both forms to predict too many Smith Periods during the season. In the case of the automated forecasts, Smith Periods were overestimated by about a factor 1.5. This suggested that the method used to calculate the forecast Smith Periods should be modified; for example by improving the calculation of hourly relative humidity.

The success rate/failure rate of the-automated forecasts can be summarised as follows:

> If the forecast is for a Smith Period the probability of it being correct is 17% (there are a large number of false alarms), whereas chance would give a probability of 10%. If the forecast is for NO Smith Period the probability of it being correct (ie negative) is 96%, compared with 90% probability by chance alone.

Since nearly all the 'bad' forecasts were borderline, a means of indicating borderline cases automatically, particularly for minimum temperature, would be an advantage. There was only one case where CFO guidance markedly improved the success rate on one 'bad' occasion when the forecast relative humidity was underestimated.

ICI thought the resumé (recorded on answerphone) clarified the information provided in the automated forecasts but the poor use of the answerphone service by other users hardly justified the time taken to provide the information each day. A less frequent resumé (perhaps twice a week) provided to ICI by a weather centre would compensate in part for discrepencies in the automated forecasts and clarify cases where conditions are borderline.

The automated forecasts showed little skill by forecast days 4 and 5. The weakest point is thought to be forecast relative humidity. Lee (1987) showed that humidity fivecasts display little skill by days 4 and 5 but, in addition, the crude, linear interpolation of humidity between the six and, particularly the twelve hour spacings of the forecast values may have further sacrificed accuracy.

Errors in the automated forecasts tended to be highest in the squares in Cornwall and Devon, where the forecast model grid points are most sparse, and where nearly all the MOS stations are coastal, which may have given a bias towards coastal effects.

Some indication of the variation with altitude of the forecasts, which are calculated for the mean square height, was required. For example, the calculations could be made for the mean potato growing height in a square and for mean sea level. This approach is being implimented in the 1988 trial.

There was one occasion where MOS failed and CFO guidance was used to produce the forecasts. This would have been prevented by an automated backup procedure.

References

Lee, M, 1987. Agricultural Memorandum 1084. "An Assessment of objective relative humidity forecasts as required for Smith Periods".

Appendix A

Summary of users' comments

(i) ICI Plant Protection thought the forecasts gave "added value" to their products, the Blight fungicide sprays, in the form of foreknowledge for their sales reps. As an illustration of the importance of technical advice, which included Blight weather forecasts, one member of ICI Plant Protection cited an example of 100 percent increased yield in crops previously grown with low technical input due to (a) the season's weather and (b) technical advice. He suggested that the influence of technical advice might contribute to 50 percent of this increase. However, an entirely different view was held by one independent crop consultant, who felt that the increased yields were due solely to the more favourable weather conditions in 1987.

The forecasts were also useful for planning activities in the forthcoming week.

(ii) The following points emerged as a result of interviews by telephone with the growers and fungicide spray merchants.

1. All users confirmed that the most important use of the forecasts was to predict the first onset of Blight weather, so that growers did not start their spray schedules too late. Users generally felt that the forecasts' timing of Blight weather onset was good.

2. Growers implied that, since so much is at stake, it would take 100 percent accuracy in the automated forecasts of Smith Periods for days 0 and 1 before they would depend on the forecasts to the extent of missing a spray or significantly altering their spraying schedule, once started.

3. 5 day forecasts of a fairly high accuracy could be useful as a management and planning tool; eg for choosing weather to use a contact or systemic spray where the difference in price could result in savings of about £10 per hectare per spray. To do this effectively forecasts of dry days and, possibly, spray occasions for at least a day ahead would be required as well as Blight weather forecasts.

4. Users generally considered Smith Periods for a range of squares rather than just the single square covering their location. One grower specifically monitored a square outside his area which he felt to be more representative of the weather in his location.

5. It was unclear whether the forecasts influencedgrowers' decisions on when to shorten spraying intervals as this appeared to be a very subjective subject.

6. Since about 60 percent of the national potato crop is irrigated (according to Potato Marketing Board statistics) it may be important to provide separate forecasts of Smith Periods calculated without the humidity criterion.

7. Growers felt that forecasts for an area of 40 x 40 km were not necessarily applicable to their individual locations, particularly if they farmed at significantly lower or higher altitudes than the mean height of their grid square.

Figure Captions

Fig 1. Area covered by 40 x 40 km grid squares

Fig 2. Example of viewdata display

Fig 3. Example of forecast message

Fig 4. Example of Potato Blight Forecast Model output received by the medium range forecaster

Fig 5. Percentage of Smith Periods correctly predicted (average for all forecast days)

Fig 6. Percentage of Smith Periods correctly predicted by forecast issued the previous day

Fig 7. Percentage of incorrect forecasts (average for all forecast days)

TABLE 1

COMPARISON OF FIRST SMITH PERIODS OCCURRING IN EACH SQUARE WITH THE FORECASTS OF SMITH PERIODS

sq. no.	date of first occurrence of Smith Period for this sq.	date of first occurrence of Smith Period at associated station	date of first occurrence of predicted Smith Period forecast for:	issued on:
157	-	-	26/5/1987	25,26/5/1987
	23/6/1987 NM* 26/6/1987	28/6/87 (Bristol)	21/6/1987	16 to 21/6/1987
158	23/6/1987 NM 26/6/1987	22/6/87 (Lyneham)	21/6/1987	16,17,20, 21/6/1987
159	27/6/1987	data not available	22/6/1987	19,20,22/6/1987
165	28/5/1987 NM 29/5/1987 NM	-	26/5/1987	25/6/1987
	2/6/1987	2/6/87 (Chivenot)	3/6/1987	3/6/1987
166	23/6/1987	data unavailable but for adjacent square 23/6/1987 (Chivenot)	21/6/1987 22/6/1987	21/6/1987 19 to 22/6/1987
167	-	data not available	26/5/1987	26/5/1987
	26/6/1987		21/6/1987	16,17,20, 21/6/1987
168	3/6/1987	-	-	
	26/6/1987	23/6/87 (Yeovilton)	22/6/1987	19,20,22/6/1987
169	28/6/1987	26/6/87 (Boscombe Down)	22/6/1987	19,20,22/6/1987
176	30/4/1987	29/4/87 (St Mawgan)	-	
	2/6/1987	-	26/5/1987	26/5/1987
	5/6/1987	-	6/6/1987	3/6/1987
	-	22/6/87 (St Mawgan)	17/6/1987	16,17/6/1987
177	23/6/1987	22/6/87 (Hartland)	21/6/1987	20,21/6/1987
178	23/6/1987	26/6/87 (Exeter)	22/6/1987	19,21,22/6/1987
179	26/6/1987	26/6/87 (Exeter)	21/6/1987	17,21/6/1987
180	3/6/1987	-	-	
	23/6/1987	23/6/87 (Yeovilton)	21/6/1987	16,17,21/6/1987
181	26/6/1987	26/6/87 (Hurn)	21/6/1987	16,17,21/6/1987
186	29/4/1987 NM 30/4/1987	29/4/87 (St Mawgan)	-	
	28/5/1987	27/5/87 (St Mawgan)	26/5/1987	26/5/1987
187	-	29/4/87 (St Mawgan)	25/4/1987	23/4/1987
			26/4/1987	24/4/1987
			29/4/1987	28,29/4/1987
	30/5/1987	27/5/87 (St Mawgan)	26/5/1987	26/5/1987
188	2/6/1987	2/6/87 (Plymouth)	26/5/1987	26/5/1987
189	30/5/1987	2/6/87 (Plymouth)	27/5/1987	27/5/1987
190	4/6/1987	3/6/87 (Culdrose)	6/6/1987	3/6/1987

* NM registered as a 'near miss' case

Table 2

TOTAL NUMBER OF FORECASTS IN EACH CATEGORY (FOR ALL SQUARES)								
FORECAST DAY N* =			0	1	2	3	4	5
CATEGORY	actual	forecast						
success	Y	Y	168	178	154	136	131	131
	N	N	1345	1435	1544	1491	1356	1300
failure	N	Y	807	718	609	661	798	854
	Y	N	55	45	69	87	90	90

where N* is the number of days elapsed since the issue of the forecast.
NB there is still a forecast for N=0 as it is predicting the humidity and temperature for the period 0900 GMT on day 0 to 0900 GMT on day 1.

Table 3

PERCENTAGE OF ACTUAL SMITH PERIODS CORRECTLY PREDICTED (ALL SQUARES)						
FORECAST DAY N* =	0	1	2	3	4	5
% AGE CORRECTLY FORECAST	75	80	69	61	59	59

Fig. 1

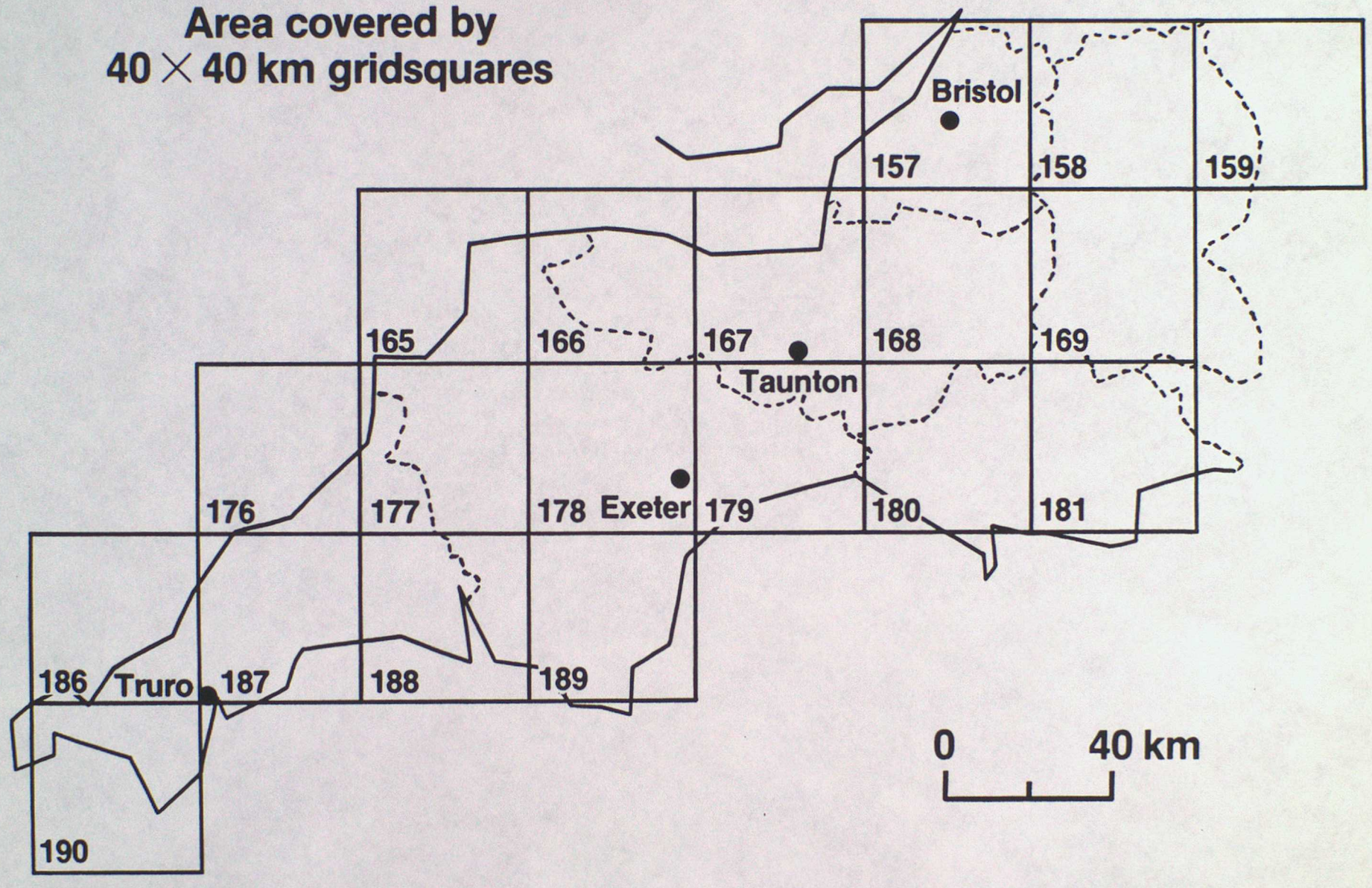
Area covered by
40 × 40 km gridsquares
Bristol
157
158
159
165
166
167
168
169
Taunton
176
177
178
Exeter
179
180
181
186
Truro
187
188
189
190
0
40 km

FIGURE 2

Met.Office (c) 1987

Forecasts of Potato Blight Weather

issued by The Met.Office on 29.06.87

Square No.	June/July 29	30	1	2	3	4
177	Y	Y	N	N	N	N
178	Y	Y	N	N	N	N
179	Y	Y	N	N	N	N
189	Y	Y	N	N	N	N
176	Y	Y	Y	Y	Y	Y
186	Y	Y	Y	Y	Y	Y
187	Y	Y	N	N	Y	Y
188	Y	Y	N	N	N	Y
190	Y	Y	Y	Y	Y	Y

Y-Yes, high risk of blight weather
N-No, low chance of blight weather

1 Other squares 2 Blight Index
8 Met Index. 9 Potato Index. *0# Index.

FIGURE 3

EXPERIMENTAL POTATO BLIGHT
WEATHER FORECAST FOR SW ENGLAND.

ISSUED - TIME : 11:55 DAY : 29/6/87

ALL AREAS OF THE SOUTH WEST WILL HAVE A HIGH RISK OF SMITH PERIODS ON MONDAY AND TUESDAY. FRESHER WEATHER SHOULD REACH THE REGION BY WEDNESDAY THUS LESSENING THE RISK IN ALL AREAS EXCEPT FOR THE NORTHERN DEVON AND CORNWALL COASTS. THESE CONDITIONS SHOULD THEN PERSIST THROUGHOUT THE PERIOD BUT ON FRIDAY AND SATURDAY MINIMUM TEMPERATURES ARE EXPECTED TO BE HIGH ENOUGH TO AGAIN CAUSE BLIGHT WEATHER IN THE WHOLE OF DEVON AND CORNWALL.

COMPILERS SIGNATURE

Sarah Masters.

FIGURE 4

*** FOR THE ATTENTION OF THE MEDIUM RANGE FORECASTER ***

SMITH PERIOD DATA FOR 9 7 1987

COL 1 = SMITH INDEX (0-2) CONSECUTIVE DAYS WITH TOTAL INDEX > 2 => A SMITH PERIOD
COL 2 = MIN TEMP IN 09-09 DAY
COL 3 = HOURS IN 09-09 DAY WITH R.H.>90%
DAY 0 IS 9 7 1987

SQUARE	DAY 0	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
157	2. 12.8 15	2. 12.7 11	2. 12.[illegible] 11	2. 11.5 12	2. 11.7 15	2. 11.5 15
158	2. 12.2 15	2. 12.2 11	2. 11.8 11	2. 10.9 12	2. 11.2 15	2. 10.7 15
159	2. 11.6 15	2. 11.8 11	1. 11.5 10	2. 10.2 12	2. 10.6 15	0. 9.8 15
165	2. 13.0 15	2. 12.7 13	0. 12.4 5	2. 12.2 12	2. 12.2 15	2. 11.4 15
166	2. 11.7 15	2. 11.6 11	1. 11.1 10	2. 10.6 12	2. 10.6 15	2. 10.5 15
167	2. 12.2 15	2. 12.1 12	1. 11.4 10	2. 10.8 12	2. 10.9 15	2. 10.8 15
168	2. 11.7 15	2. 11.6 11	2. 11.2 11	2. 10.3 12	2. 10.5 15	2. 10.2 15
169	2. 11.4 14	2. 11.6 12	2. 11.[illegible] 12	2. 10.2 12	2. 10.5 15	2. 10.1 15
176	2. 12.7 15	2. 12.7 15	0. 12.5 5	2. 12.2 11	2. 12.2 15	2. 12.2 15
177	2. 11.9 15	2. 12.1 15	0. 11.8 6	2. 11.4 12	2. 11.3 15	2. 11.6 15
178	2. 11.7 15	2. 11.9 13	1. 11.9 10	2. 11.1 12	2. 10.8 15	2. 11.4 15
179	2. 11.4 15	2. 11.6 14	0. 11.7 9	2. 10.7 12	2. 10.5 15	2. 11.1 15
186	2. 11.4 15	2. 11.7 12	2. 11.7 11	2. 10.6 12	2. 10.6 15	2. 11.0 15
181	0. 10.9 8	2. 11.6 11	1. 12.1 10	1. 10.4 10	2. 10.6 13	2. 11.0 13
188	2. 13.0 15	2. 13.0 15	0. 12.0 5	0. 12.4 5	2. 12.6 15	2. 12.7 15
187	2. 12.5 15	2. 12.7 15	0. 12.5 5	2. 12.1 13	2. 12.0 15	2. 12.5 15
188	2. 12.1 15	2. 12.4 15	0. 12.1 7	2. 11.7 13	2. 11.5 15	2. 12.1 15
189	2. 11.7 15	2. 12.0 15	1. 11.8 10	2. 11.3 13	2. 11.0 15	2. 11.8 15
190	2. 12.3 15	2. 12.4 15	0. 11.9 5	2. 11.8 15	2. 12.0 15	2. 12.2 15

SQUARE	COUNTY	DAY 0	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	TOTAL
157	SOMSET	1	1	1	1	1	1	6
166	SOMSET	1	1	1	1	1	1	6
167	SOMSET	1	1	1	1	1	1	6
168	SOMSET	0	1	1	1	1	1	5
158	WILTS	1	1	1	1	1	1	6
159	WILTS	0	1	1	1	1	0	4
169	WILTS	0	1	1	1	1	1	5
180	DORSET	1	1	1	1	1	1	6
181	DORSET	0	0	1	0	1	1	3
165	DEVON	1	1	0	0	1	1	4
177	DEVON	1	1	0	0	1	1	4
178	DEVON	1	1	1	1	1	1	6
179	DEVON	1	1	0	0	1	1	4
189	DEVON	1	1	1	1	1	1	6
176	CORNWL	1	1	0	0	1	1	4
186	CORNWL	1	1	0	0	0	1	3
187	CORNWL	1	1	0	0	1	1	4
188	CORNWL	1	1	0	0	1	1	4
190	CORNWL	1	1	0	0	1	1	4

Fig. 5

PERCENTAGE OF SMITH PERIODS CORRECTLY PREDICTED

(average for all forecast days)

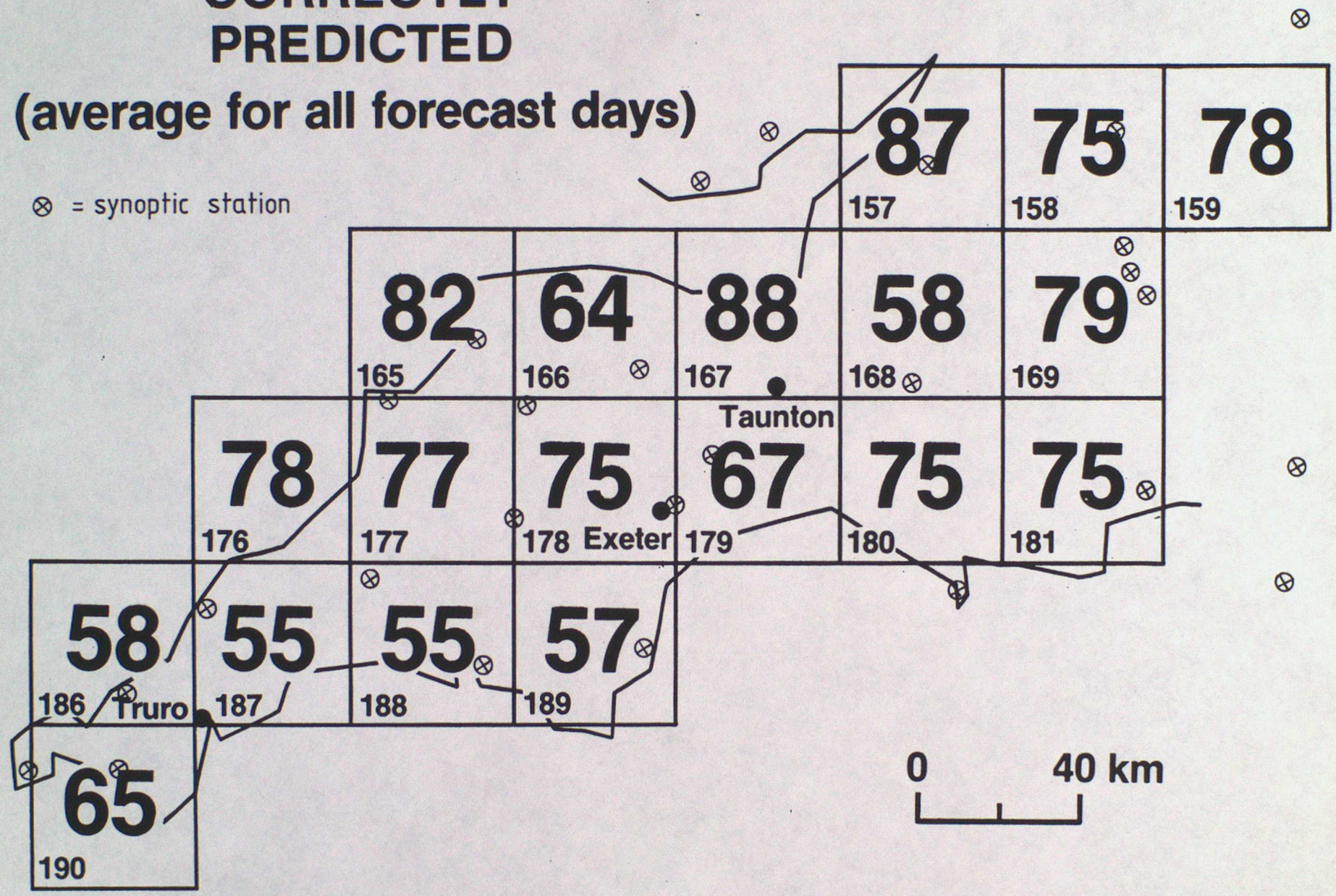

Fig. 6

PERCENTAGE OF SMITH PERIODS CORRECTLY PREDICTED BY FORECAST ISSUED THE PREVIOUS DAY

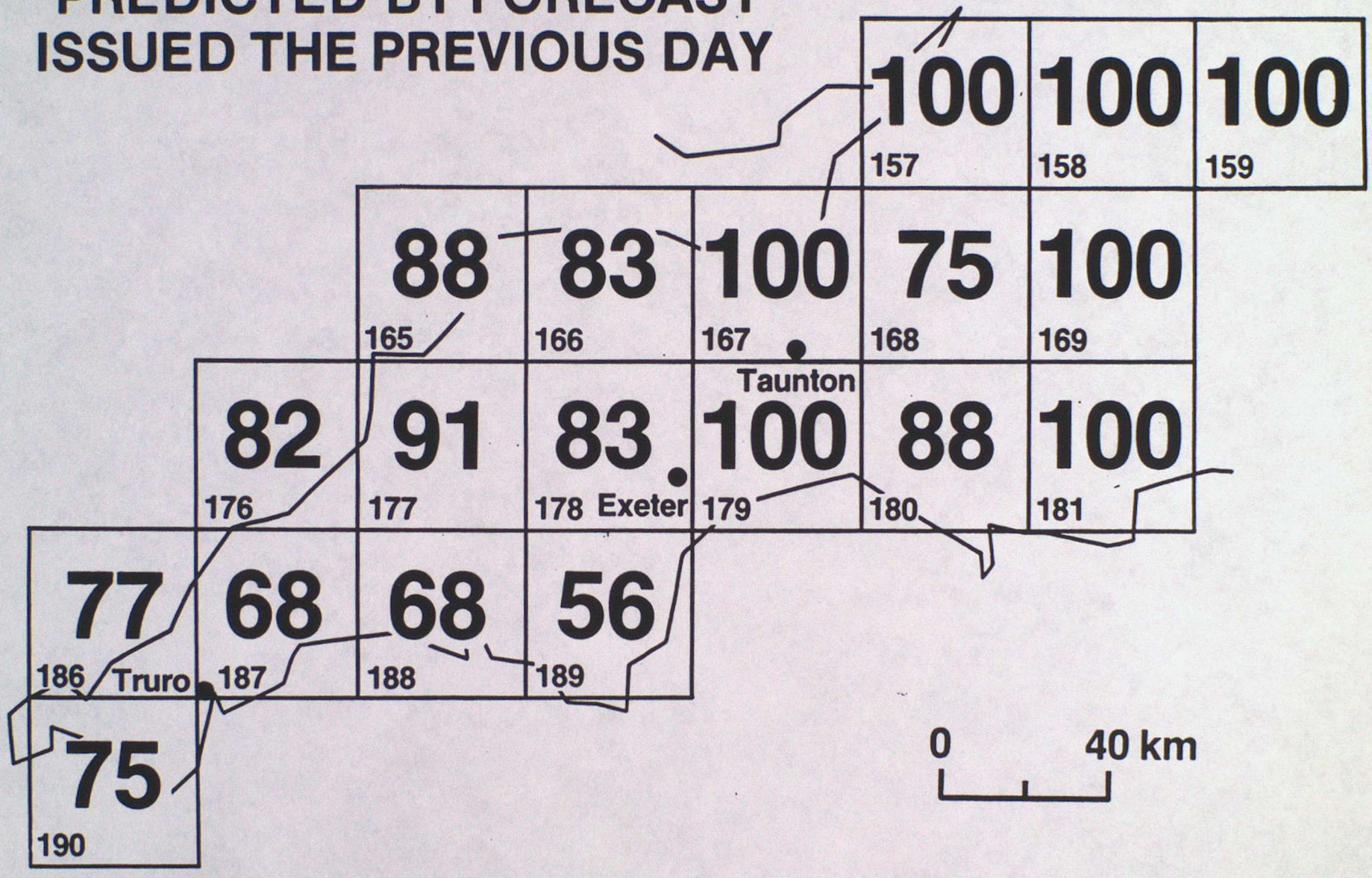

Fig. 7 **PERCENTAGE OF INCORRECT FORECASTS**

(average for all forecast days)